

The study of cloud and aerosol properties during CalNex using newly developed spectral methods

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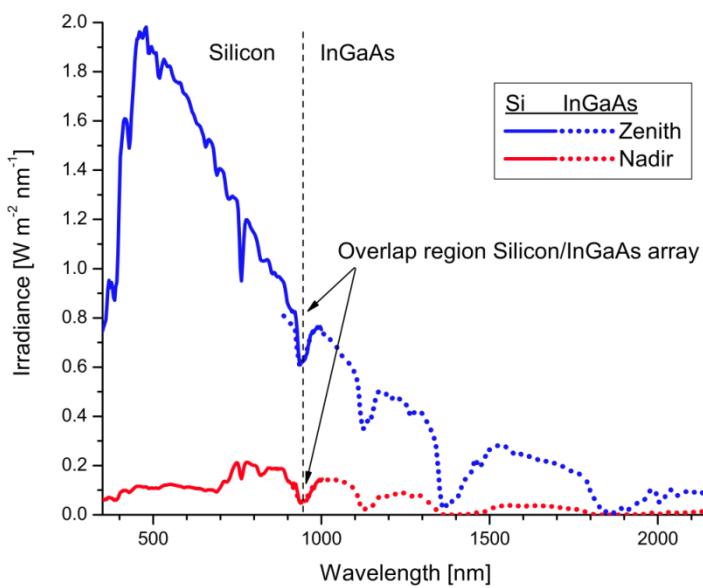
Chris Fairall, Dan Wolfe, Sara Lance
NOAA/ESRL, Boulder, CO

Patrick Minnis, Kristopher M. Bedka, Chris Hostetler, Rich Ferrare
NASA Langley, Hampton, VA

Warren Gore, Jens Redemann, Philip B. Russell
NASA Ames, CA

CalNex data workshop, Sacramento, CA

P3 Instrumentation

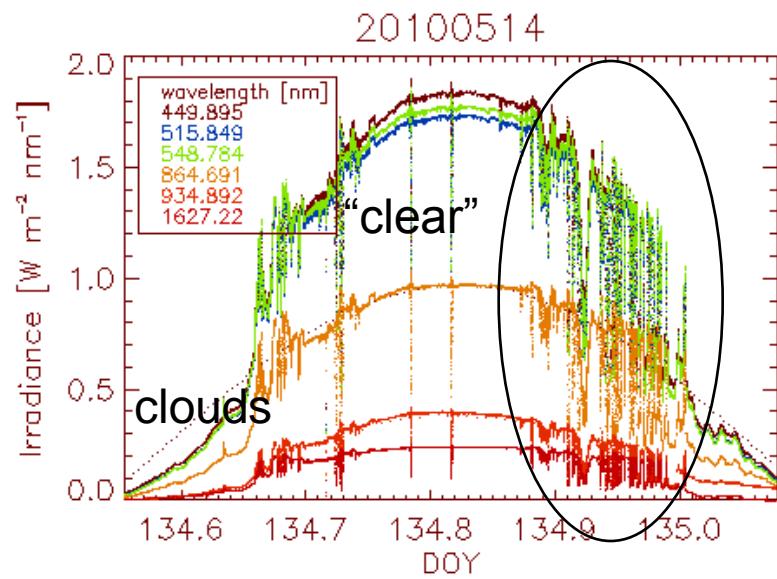


Solar Spectral Flux Radiometer

- Zenith and nadir viewing spectral irradiance at 411 wavelengths
- Sampling frequency of 1 Hz
- Spectral range: 350-2100 nm

In-situ
Cloud microphysics
Aerosol optical properties

Atlantis Instrumentation



SSFR

- Zenith viewing irradiance and radiance reported at 313 wavelengths
- Sampling frequency of 1 Hz
- Spectral range: 350-1700 nm

Microwave radiometer (MWR)

Retrieves column integrated liquid water and water vapor

Cloud Radar

Provides profiles of backscatter from cloud

Other data sources



Geostationary Operational Environmental Satellites (GOES)

Provides cloud optical thickness and effective radius over 4 km.

High Spectral Resolution Lidar (HSRL)

Profiles aerosol extinction coefficients at 532 nm

Cloud remote sensing



Atlantis cloud retrievals

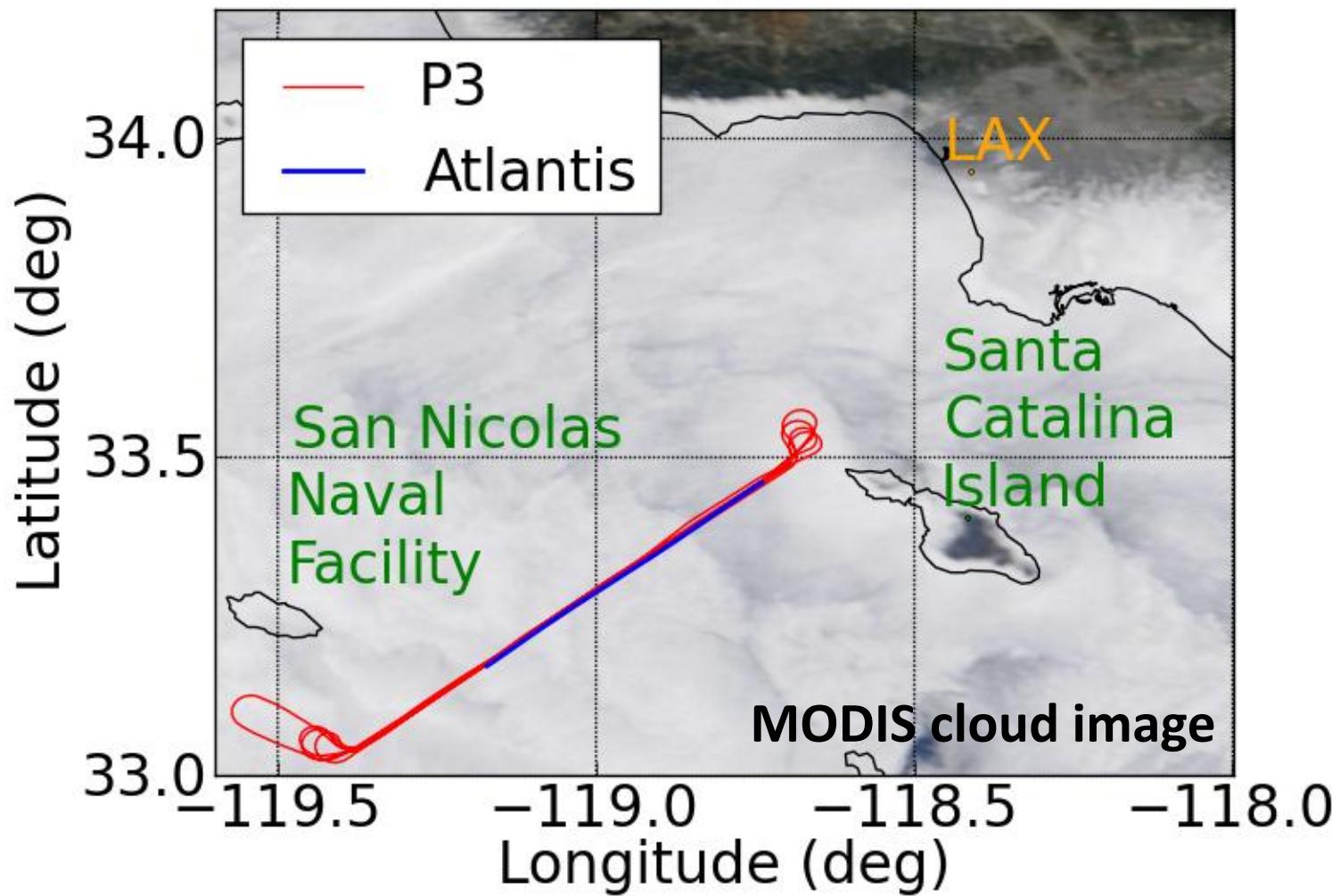
Cloud property (τ , r_{eff} , LWP) retrievals performed for the first time on the SSFR and derived from transmitted spectral radiance. Near real-time cloud retrieval.

(See McBride et al., *A spectral method for retrieving cloud optical thickness and effective radius from surface-based transmittance measurements*, ACPD, 2011a.

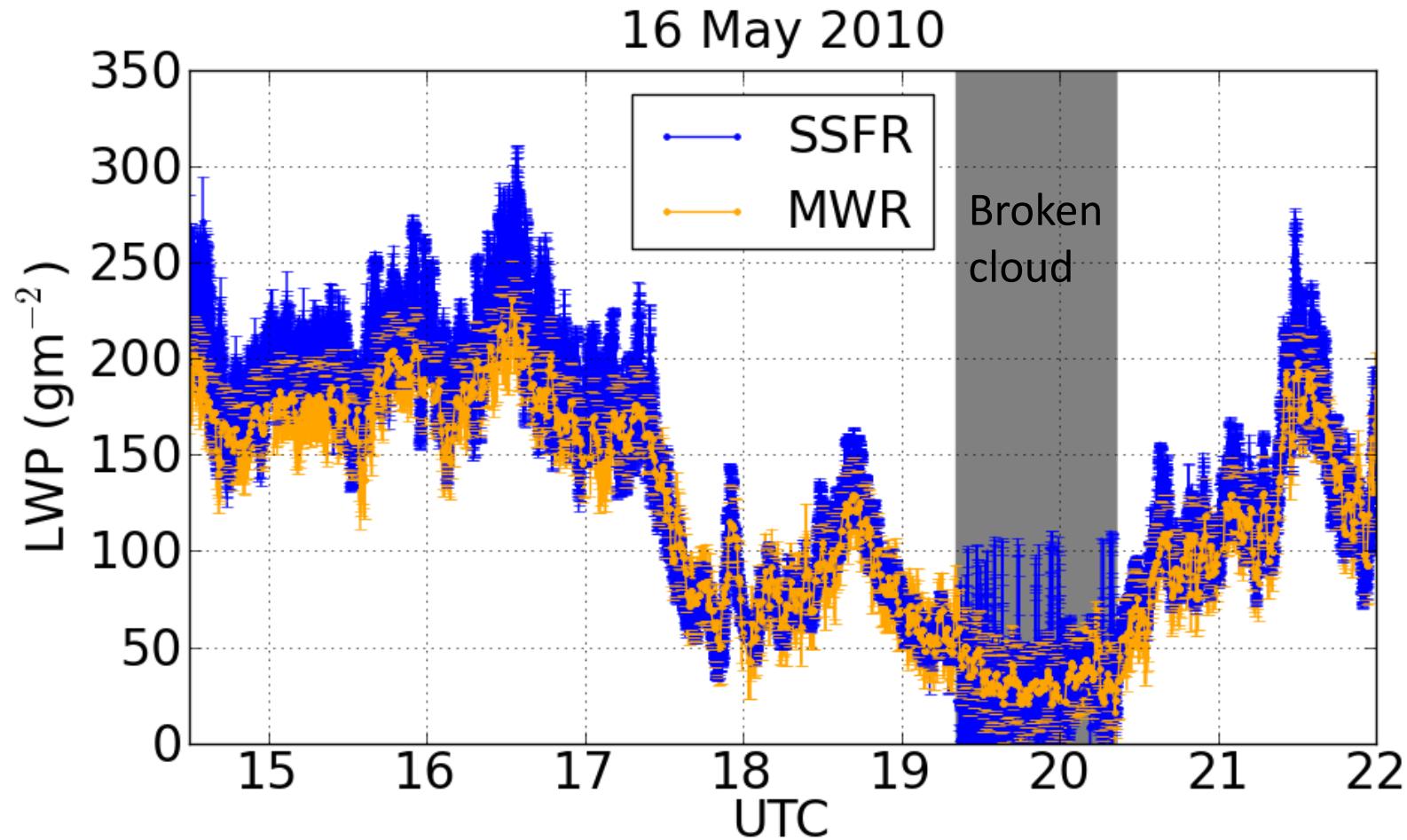


- Satellite validation
- Can derive radiative forcing

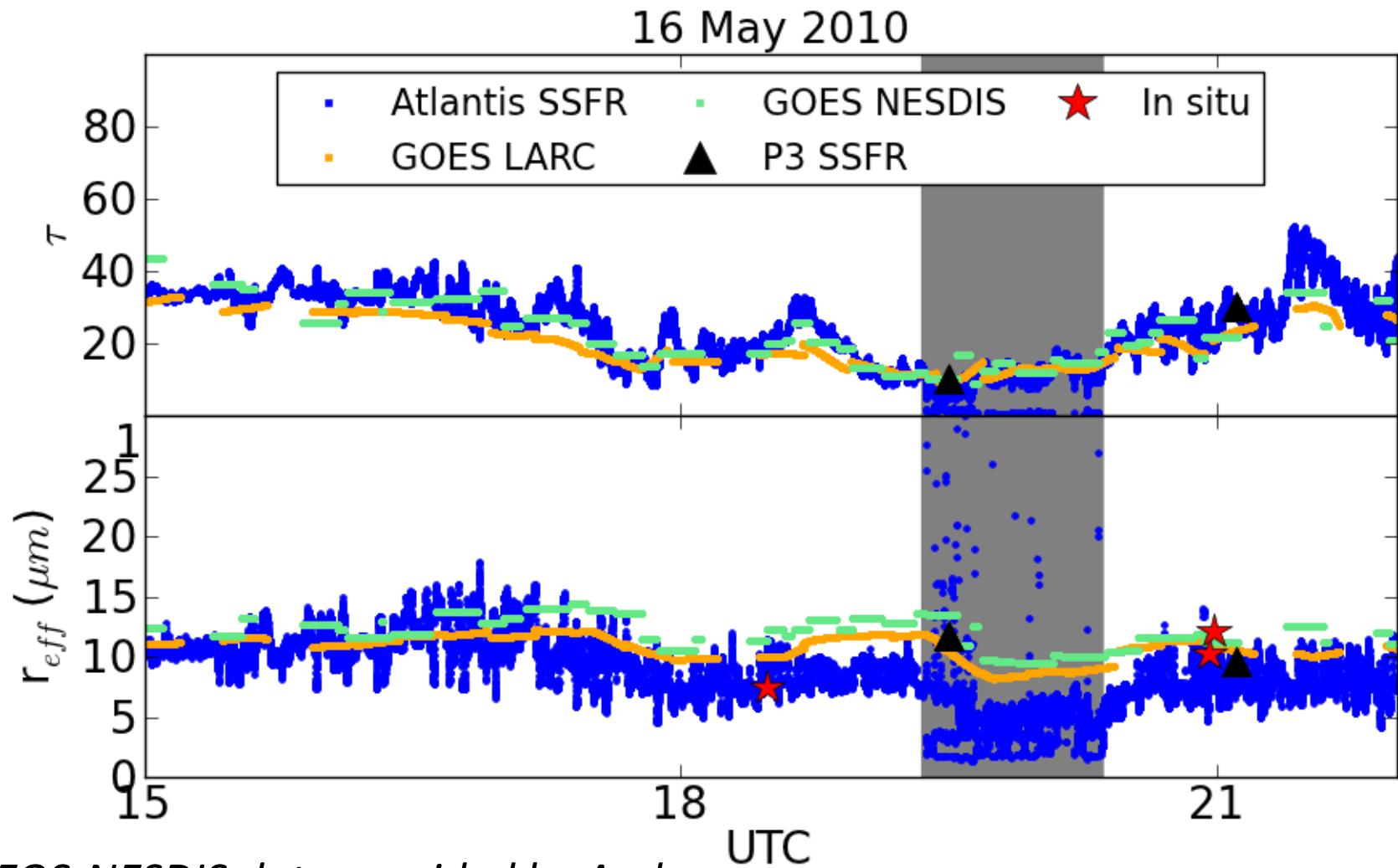
16 May 2010



Microwave radiometer comparison



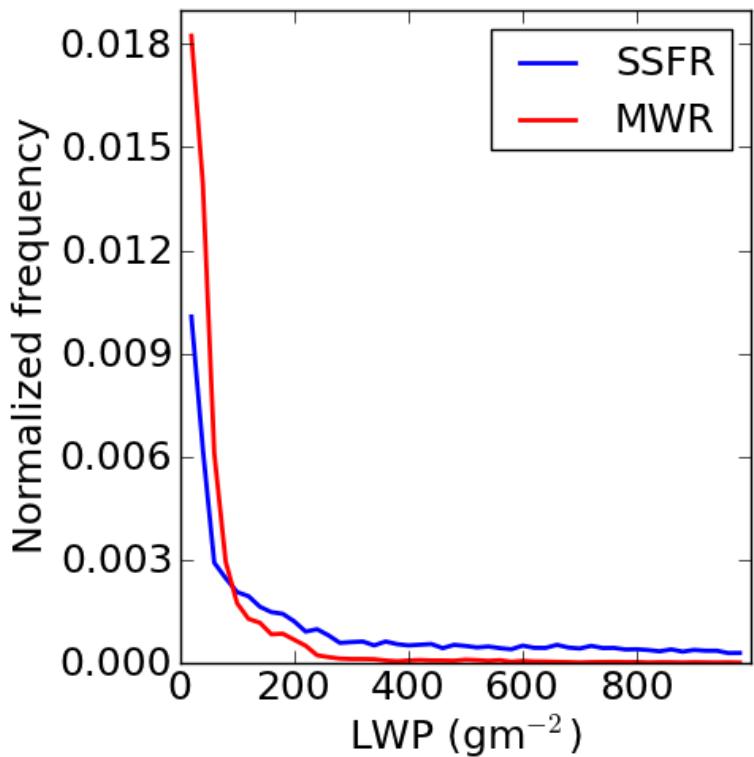
Comparing multiple platforms



*GEOS-NESDIS data provided by Andy
Heidinger and Andi Walther*

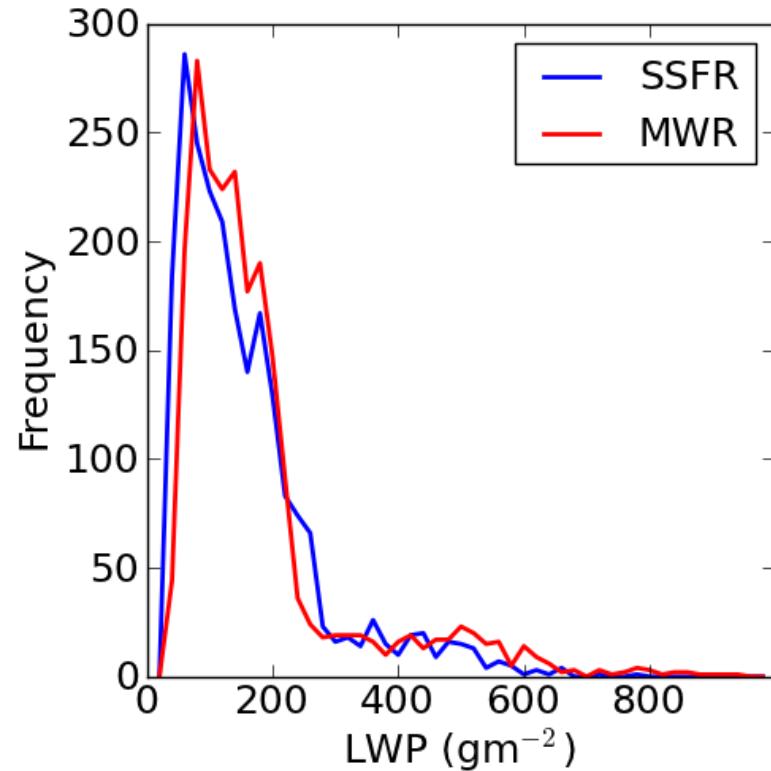
McBride et al. 2011b, In preparation

Atlantis LWP statistical comparison



Histogram for all times where
LWP > 30 gm^{-2} (1 minute averages)

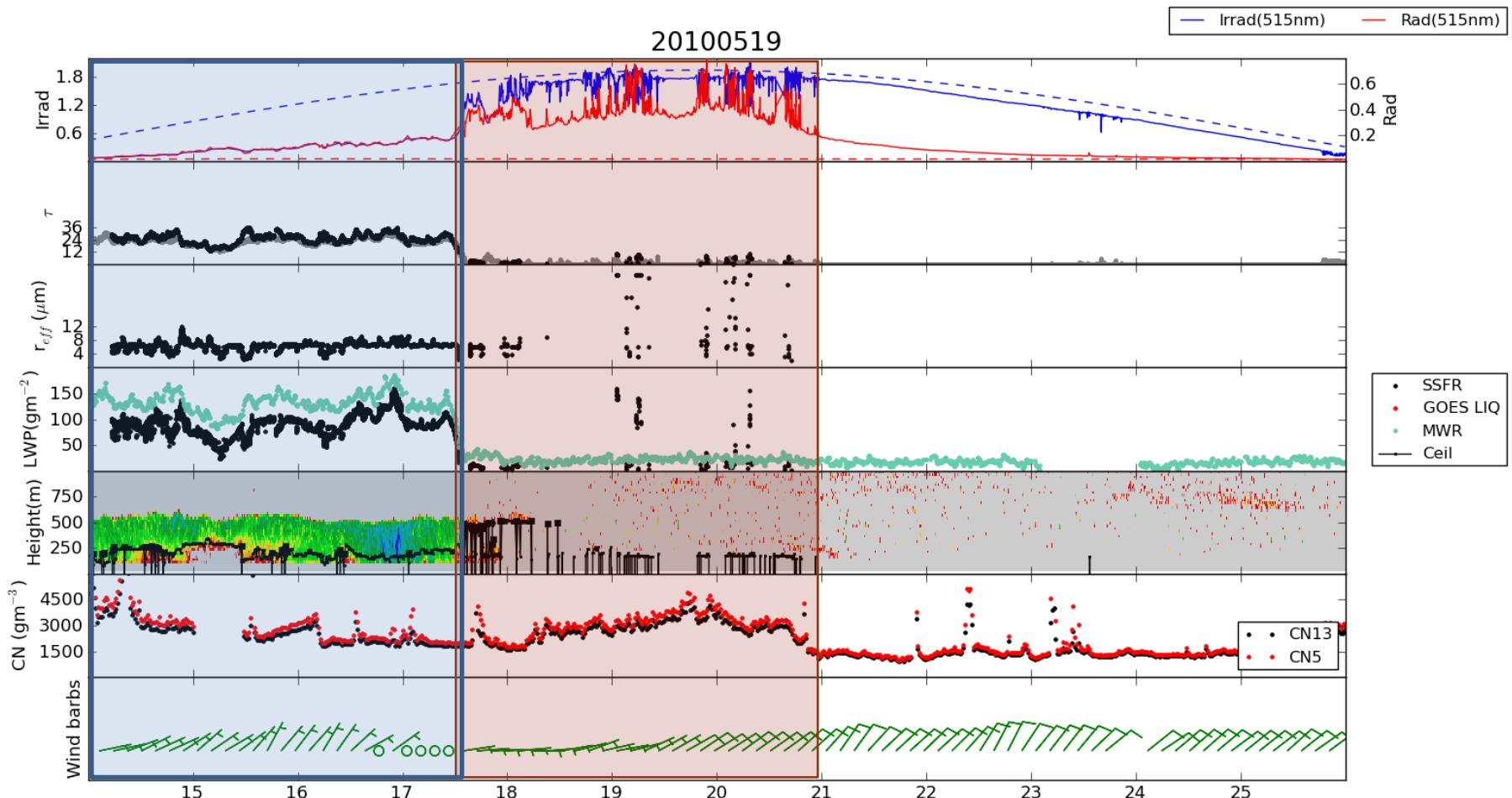
Still to do: Statistical analysis with
GOES cloud properties



Histogram filtered for overcast cases
Factors still to be explored:

- Cloud inhomogeneities
- Cloud phase
- Number of cloud layers
- Precipitation
- Polluted cloud

Collaborative cloud observations



Broken cloud cases

Overcast cases

Aerosol remote sensing

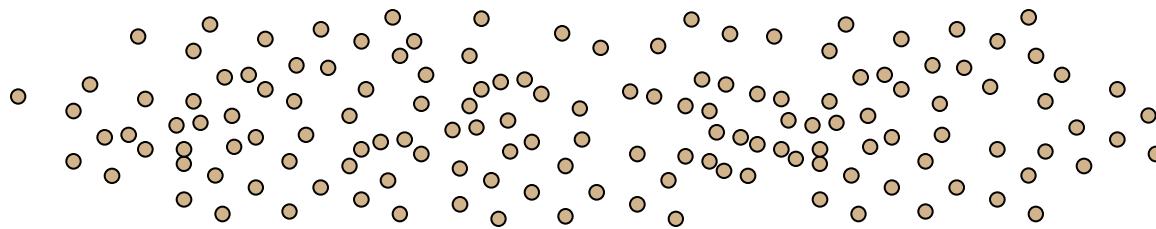


NASA King Air



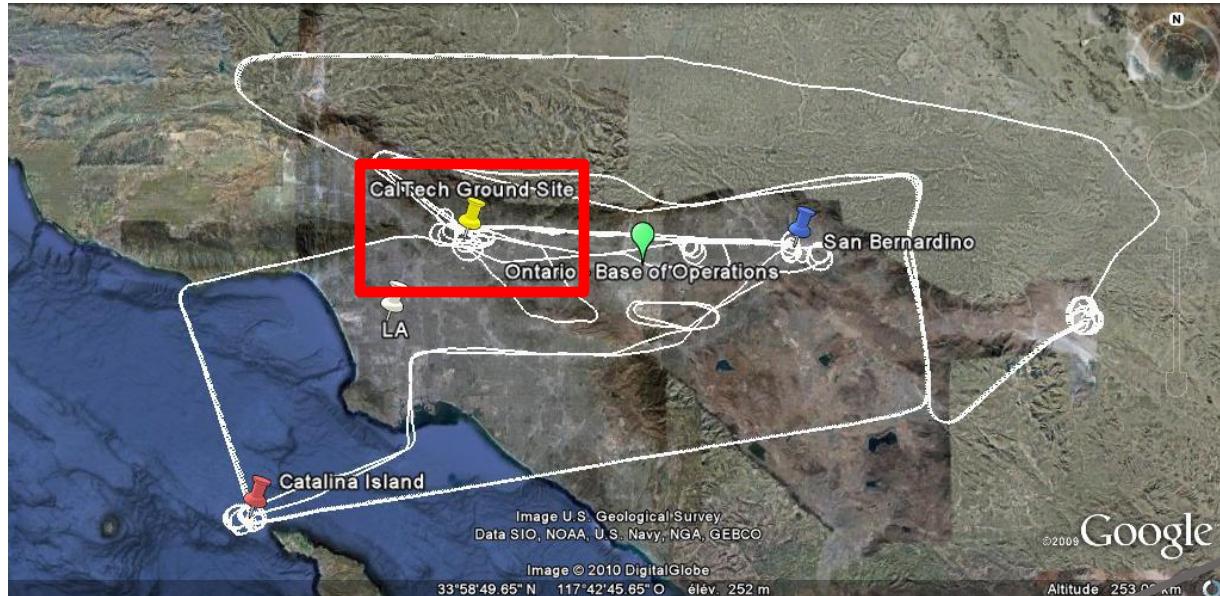
NOAA P3

g , ω , τ



NOAA R/V Atlantis

Aerosol optical property retrievals



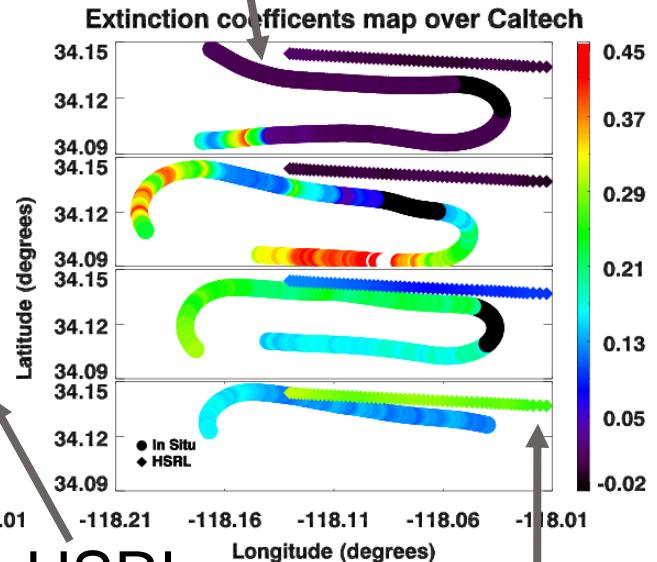
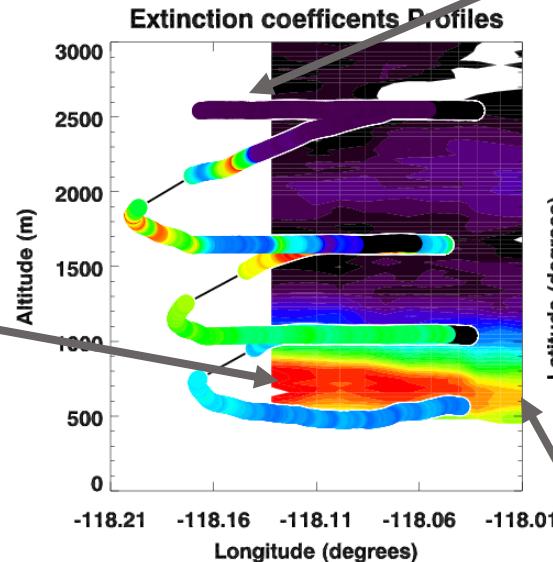
19 May 2010

In situ Cavity Ring
Down (CRD)

30 min. between HSRL
and CRD data

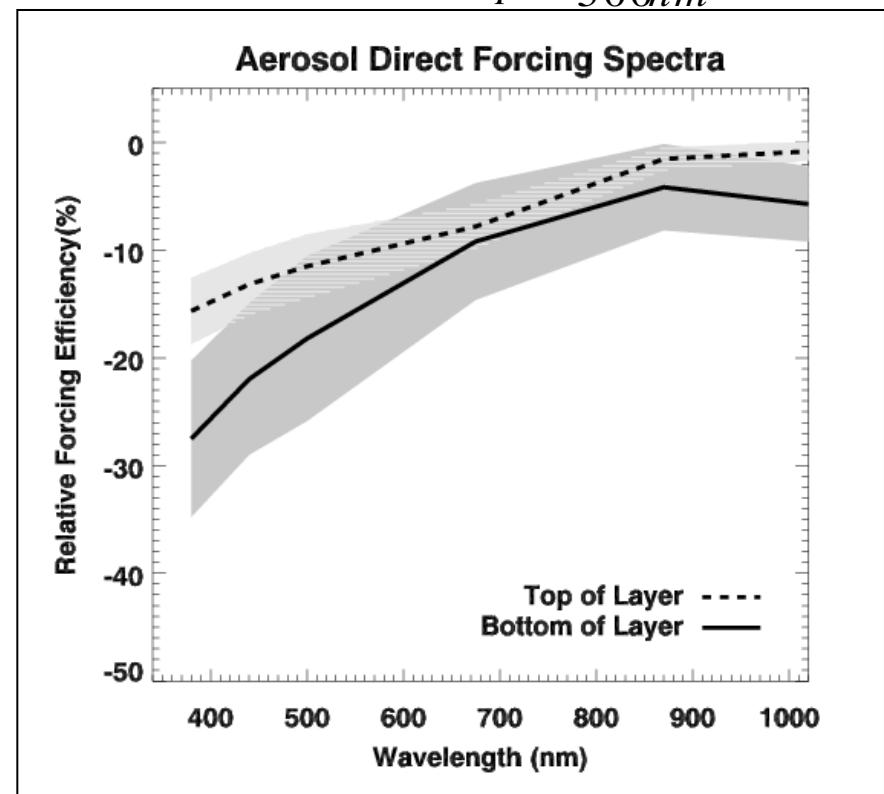
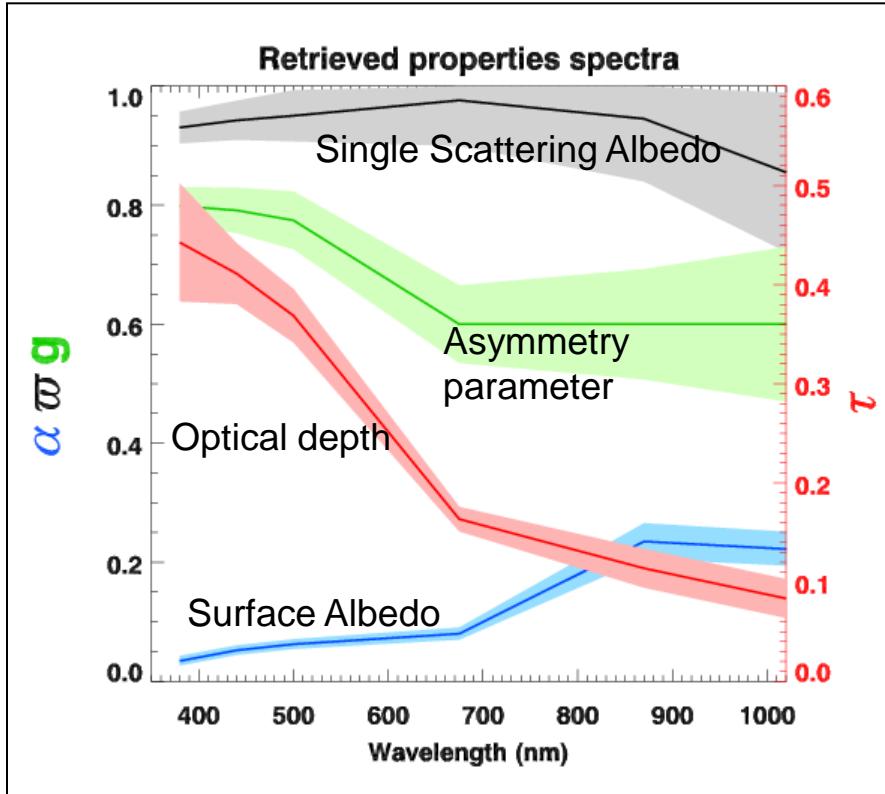
Retrieved aerosol
properties for this
aerosol layer

*CRD data provided by Justin
Langridge, NOAA*



Aerosol retrieval results

$$\text{Relative forcing efficiency} = \frac{100\% \cdot (F_{net,polluted} - F_{net,clear})}{F_{top}^{\downarrow} \cdot \tau_{500nm}}$$



Inputs to the retrieval:

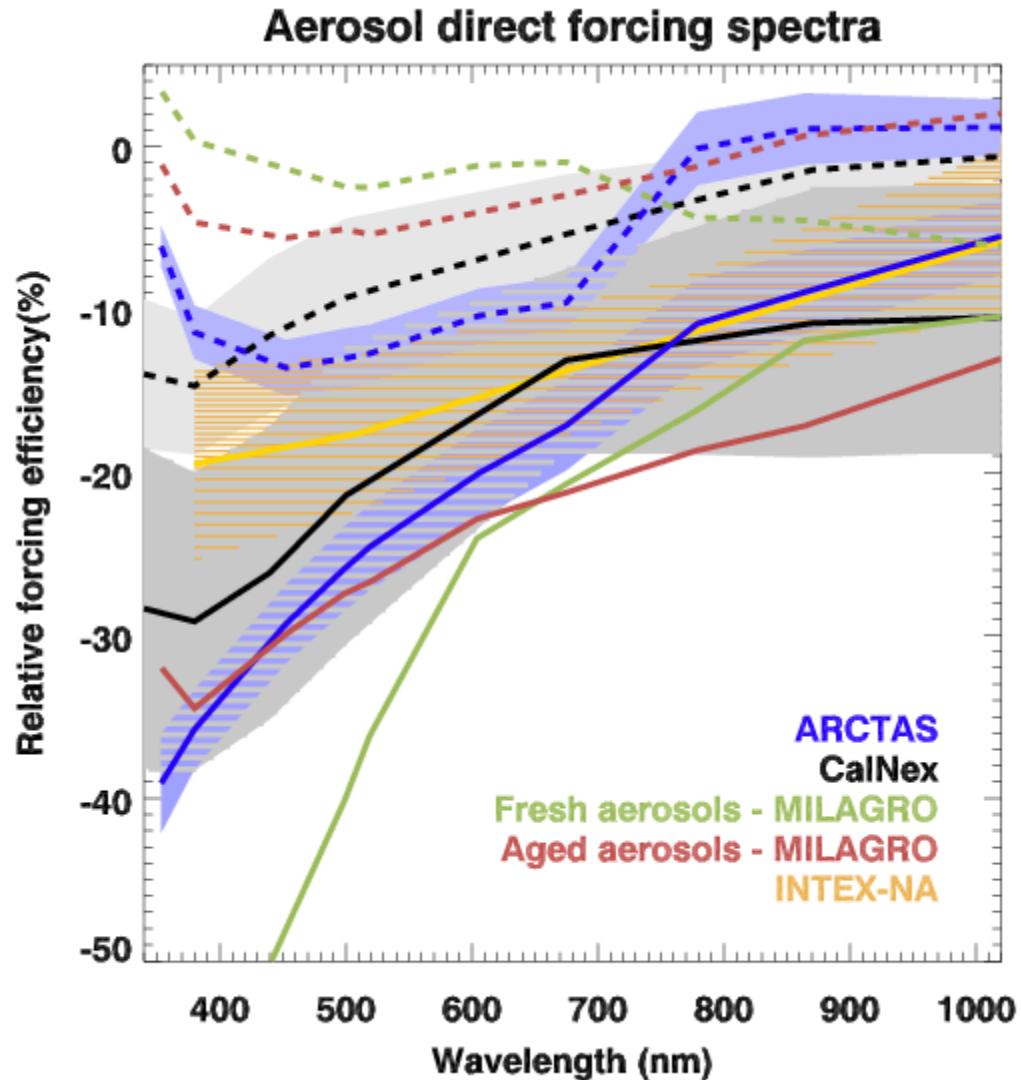
- SSFR irradiance
- Aeronet Angstrom parameter
- HSRL extinction

Relative forcing efficiency comparison

Relative forcing
efficiency

$$\frac{100\% \cdot (F_{net,polluted} - F_{net,clear})}{F_{top} \cdot \tau_{500nm}}$$

Spectral shape of relative
forcing efficiency
comparable to within 15%
of previous results



Capabilities

- ❑ Ability to retrieve cloud properties (τ , r_{eff} , LWP) from transmitted spectral radiance
- ❑ Studying cloud optical properties from above and below using statistical methods
- ❑ Aerosol optical property retrieval (g , ω , τ) without simultaneous optical thickness observation
- ❑ Relative forcing efficiency is within 15% of previous experiments

Future work

- ❑ Statistical comparison of different viewing geometries
 - . Using in-situ observations, cloud radar, microwave radiometer, satellite data
- ❑ Aerosol-cloud interaction study
- ❑ Ship-based aerosol property retrievals
- ❑ Simultaneous retrieval of aerosol and cloud properties under overcast and broken cloud fields

SSFR data information

NOAA P3

- 30 flights
- 151 hours of data collected
- Over 543,000 spectral collected
- Spectra reported at 411 wavelengths over the range 350 to 2150 nm
- Data archive location
www.esrl.noaa.gov/csd/tropchem/2010calnex/P3/DataDownload/index.php

R/V Atlantis

- 273 hours of data collected
- Over 983,000 spectra collected
- Spectra reported at 313 wavelengths over the range 350 to 1700 nm
- Data archive location
<ftp://lasftp.colorado.edu/pub/schmidt/calnex/atlantis/>